CHARACTERIZING RISKS: CAN DOE ACHIEVE INTERSITE EQUITY BY 2006?

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ABSTRACT

DOE wants to ensure that decisions coming from the Waste Management PEIS (WM PEIS) and the 2006 Plan are equitable, responsible, and scientifically defensible. In order to be able to substantiate this, however, certain types of information about community impacts that have never been collected will be needed. This pap&r presents an initial description of the required information, although no plans to gather that information are known to us. The general information requirements apply to all affected communities, but this paper deals primarily with tribal communities. The interconnectedness of people, their geographic place, their resources, their culture, their health, their art, their religion, their trade networks, their social and survival activities, and their past and future means that evaluating community impacts around DOE Sites must be done with as much attention to breadth, depth, and time as to detailed numerical analysis. A study of distributions of impacts to different population segments at individual Sites and between Sites must be done to support the 2006 Plan and the WM PETS. A quality assessment must be designed to evaluate a wide range of individual measures selected by the affected communities, including tribal communities. It should include an assessment of uncertainty across the various parts of the analysis (source terms, post-closure containment, transport, impacts), and the time frame of analysis must extend for as long as the material remains hazardous or for as long as the harm persists.

An evaluation of the 2006 Plan and WM PEIS quickly shows that the supporting analyses fall far short of the quality necessary to support the selection of the preferred alternatives. Based on our evaluation of the WM PEIS and the 2006 Plan and our interpretation of Executive Order 12898 (Environmental Justice) and DOEs and EPA's American Indian Policies, we conclude that DOE is not meeting its Federal Trust obligations, not honoring treaty-reserved rights, not adequately protecting human health and the environment, not pursuing environmental justice, and is worsening the inequities that already exist between DOE Sites. In fact, it can be easily shown that the entire Pacific Northwest will be adversely impacted for tens of thousands of years by the decisions made from the WM PUS and 2006 Plan, and that the American Indian Tribes near the Hanford Site will bear the most significant portion of that impact. The regional impacts are not being evaluated, however, so the distribution of impacts among Sites cannot be evaluated. Criteria for achieving equity are undefined, but we can show that the trend evident in the WM PEIS and 2006 Plan is to worsen the inequities that already exist by virtue of the tremendous contamination already present at Hanford, not improve them.

GENERAL COMMUNITY PERSPECTIVES

All environmental problems pose various types and degrees of risk to human health, to ecological systems, and to society's quality of life. Communities generally prefer to take a holistic approach when evaluating impacts to their entire sphere of influence (EPA, 1993). They prefer to systematically examine the range of 'things that need to be protected," the stressors that threaten those important things, the magnitude of the threat or risk, and the urgency of reducing those risks. Then, solutions or technologies can be selected and cost and schedules can be planned. The overall result is that cost and schedule are constraints on meeting higher level environmental quality goals. This is a very important point - that values, goals and principles drive the process, and cost and schedule are merely constraints. This is opposite the usual DOE paradigm in which cost, schedule and available technology determine what goals are achievable and the quality of the outcomes, while values and principles are relegated to a role as minor weighting factors, or constraints on implementing business as usual.

The U.S. Environmental Protection Agency has been working with states, communities, and tribes for well over a decade in evaluating this range of risks because environmental managers need this information to identify and prioritize environmental management activities (EPA, 1993). Having this information allows environmental managers to plan risk reduction and prevention strategies knowing the full range of impacts, and encourages them to clearly define goals, values, and principles (such as habitat protection and equity) worked out in common with the affected communities. It also allows the evaluation of life-cycle (and future) risks, risks imported or exported from the affected area, and a variety of spatial and temporal scales.

This is a community-centered perspective rather than a federal project managers budget-centered perspective. The historical problems that arose when risk assessment and risk management were artificially separated in 1980 (CEQ, 1989) continues to plague the federal government. This has been perpetuated through the myth that real risk is different from perceived risk (we won't go into an analysis of risk relativism or mental models that perpetuate this myth here), and that risks are different from impacts or hazards. The U.S. Environmental Protection Agency, the National Research Council, 1994, 1996), the President's and Congressional Commission on Risk Assessment and Risk Management (1997), along with other agencies, are moving to correct these problems. Unfortunately, DOE remains mired in an old dogma that is escalating the confrontation between archaic methodology and the reality of community impacts.

TRIBAL SOVEREIGNTY AND TREATY RIGHTS AT SOME DOE

All DOE Sites that affect tribal lands must acknowledge aboriginal rights and Federal Trust obligations. Some of DOE's Sites have affected American Indian Tribes who have additionally signed treaties. For instance, Hanford is located entirely on land ceded from the UmatillalCayuse/Walla Walla and Yakama Tribes and Bands in the Treaties of 1855, and on which the tribes retain treaty-reserved rights to access and use the resources, a fact that has been completely overlooked in the ~AIM PEIS and 2006 Plan. Tribal communities have many concerns that are similar to any community's concerns (such as a need for a holistic approach including the consideration of human, ecological, and cultural health), but with the overriding need to see a federal commitment to meeting Federal Trust obligations and to protecting treaty-reserved rights. Because these are so misunderstood, we will briefly describe them here.

What is Tribal Sovereignty?

Federally recognized Indian tribes are sovereign nations within the United States whose existence predates the formation of the United States. Sovereignty is a power inherent within the Indian people, not derived from or granted by the federal government. The most basic principle of Indian law is that sovereign powers are not delegated from or granted by express acts of Congress, but rather are
inherent powers belonging to the original inhabitants which have never been extinguished. Four prime attributes of sovereignty are (1) a secure land base, (2) a functioning economy, (3) self-government, and (4) cultural vitality. The tribes' continued existence and autonomy depends upon maintaining all four attributes of sovereignty.

A clean and functioning tribal land base is crucial to a tribe's sovereignty. Maintaining a homeland where present and future generations may live is a dominant feature of tribal integrity. The meaning of this land is very different to native nations than it is to the dominant society. The tribal territory may include reservation lands as well as off-reservation areas that have cultural significance and provide sources of sustenance. This homeland supports a resident population, is the basis of the tribal economy and trade network, and provides an irreplaceable forum for a living religion and ancient cultural traditions that are based on the irreplaceable interconnectedness of every part of the region. This homeland is the resting place of ancestors, whose essence and substance is continually recycled through plants, animals, people, and the earth. For Hanford tribes, water, salmon, berries, roots, elk, deer, and medicines are an important cultural lifeline between generations. The culture is sustained and enhanced by the environment and the culture/religion protects the environment. Tribal culture is often said to be a living environmental management religion dependent on (and respectful of) a clean and intact environment -- many 'religious' activities are simply a part of practical every day life, and actions that might be labeled "sacrilegious" can actually be a threat to the survival of an individual and his/her community. This "Natural Law" given by the Creator's the highest law to which tribal peoples (and the courts) look for guidance, along with inherent sovereignty. Federal Trust

responsibility also derives from these pre-existing and inextinguishable laws. These may be thought of as the *unwritten* law that supersedes later written laws.

What are the Tribal Nations' Treaty Rights?

The three Hanford tribes (Yakama, Umatilla, and Nez Perce) are 'treaty tribes,' and have been designated as 'affected tribes" under the Nuclear Waste Policy act of 1982. The most significant *written* law relating to environmental quality for the Yakama Nation and Confederated Umatilla Tribes are their respective Treaties of 1855 and numerous court actions that have upheld these treaties. These treaties between the federal government and (a) the Yakama tribes and bands and (b) the Umatilla, Cayuse, and Walla Walla tribes ceded thousands of square miles to the United States, while retaining the core reservation lands for the Yakama Indian Nation and for the Confederated Tribes of the Umatilla Indian Reservation. The treaties confirmed that the tribes retain perpetual rights to be exercised in common with the citizens of the territory on the "open and unclaimed' lands within and beyond the boundaries of the ceded area 'for as long as the grass shall grow," including all of the Hanford Site. These rights were not granted by the U.S. government to the tribes, but were retained by the original owners of the land (the tribal nations) and recognized by the U.S. government when recorded in the treaties. The treaties are still active, valid, and upheld by courts, and may not be amended.

The Treaties also confirmed the existence of the pre-existing fiduciary trust responsibility of the United States government to assure that tribal-specific land uses in the ceded areas be maintained in a manner consistent with safe exercise of treaty reserved rights for as long as the grass shall grow. Tribes, states, and the federal government (U.S. Fish & Wildlife, and the Department of Energy) are the joint trustees of Hanford's natural resources. The treaties protect (or reserve) rights of access and use that support the continuity and well-being of the tribal people, and their age-old cultural traditions taught by their ancestors and established though millennia of interaction with the environment. This traditional culture is resilient and robust, and ensures survival through drought and flood, feast and
famine, health and sickness. It is being modified as modern aspects are incorporated into every day life, but the underlying core values and practices are carefully maintained. Specific treaty-reserved rights include hunting, gathering, pasturing, fishing, access to and care of sacred sites, and many other unlisted activities necessary to support the traditional way of life, including religious, social, cultural, and subsistence activities. Impacts to the ability to safely practice these activities on Hanford lands, to the continuity of access and safe use, and to the integrity of the environment form the focus of tribal risk assessment, cleanup, and restoration.

TRIBAL VALUES-BASED PERFORMANCE REQUIREMENTS FOR WASTE MANAGEMENT ACTIVITIES

As tribal staff, our actions are based on our need to protect our peoples' Trust and treaty rights as well as community health. Therefore, our highest goal is *"to protect the continuity and well-being of the people.'* Additionally, we help protect tribal sovereignty, rights, people, health, values, natural and cultural resources, and a traditional way of life. Therefore, we evaluate federal actions for their impacts on (1) tribal rights/sovereignty, (2) individual and community health over many generations, (3) ecosystems, ethno-habitats or ethno-ecosysterns, natural and cultural resources, and landscapes, and (4) on the ability to practice traditional religion and the traditional way of life. We evaluate this as a whole package, and not just as thresholds of acceptability for individual metrics. We must also evaluate federal actions for their underlying commitment to meeting federal trust obligations to tribes, to equity and environmental justice, to precautionary decision making, to the sustainability of ecosystems and cultures, and to the health and range of options available to future generations.

In traditional tribal communities, people, their geographic place, their resources, their culture, their health, their art, their religion, their trade networks, their social and survival activities, and their past and future are all interconnected. A healthy ethno-habitat or ethno-ecosystem is one that supports its natural plant and animal communities and sustains the biophysical and spiritual health of its native peoples. Ethno-habitats or ethno-ecosystems are places defined and understood by groups of

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people within the context of their culture. These are living systems that serve to help sustain modem Indian peoples' way of life, cultural integrity, social cohesion, and socio-economic well-being. These lands which embody these systems encompass traditional Indian homelands, places, ecological habitats, resources, ancestral remains, cultural symbols, and cultural heritage. Larger ethno-habitats can include multiple interconnected ecosystems, discrete geographical and seasonal use areas, and access corridors. The measures used to evaluate impacts to the ethno-habitat would include ecological metrics as well as impacts to the human uses of those resources (as presented in NEPA statutory language). Characterization of cumulative risks would include community-level exposure burdens, impacts on multi-generational individual and community health, and impacts on heritable cultural units and teachings related to particular places and resources.

WHAT IS AN EQUITY ASSESSMENT?

Although the WM PEIS (DOE 1997a) and 2006 Plans (DOE 1997d,e) claim to address equity, the information needed to support this claim has not been gathered. An ELS that needs to evaluate equity implications of several alternatives would include information present in standard BISs with some additional information, as follows:

A. Distributions

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Distribution of each of the impacts across demographic and ethnic groups (with constructed scales and bar charts showing comparisons);
- Proportion of the most-affected group actually affected after integrating all impacts for selected population segments
- Historical disproportionality and cumulative disproportionality
- Interim mitigation measures available before full restoration of equity across demographic and ethnic groups
- Sum of cumulative impacts within each impact type plus any synergism between stressors and endpoints)

B. Integration of the Impacts

- By type and timing of effect (human health, environmental, socio-cultural, socio-economic, etc.)
- By web type (foodweb, cultural web, economic web, etc.)
- By level of organization or unit of selection (individuals, community, regional, national; applies to both biotic communities and human communities and cultures as units of selection.)

C. Risk Profiles and Stewardship Assessments

- Life cycle risks over the lifespan of the hazardous material, including containment performance
- Risk profiles on a geographic frame of reference, including transportation corridors
- Long-term perpetual care and stewardship needs for up to tens of thousands of years, based on the half lives and toxicity of the disposed wastes.

INFORMATION WE NEED TO EVALUATE EQUITY IMPLICATIONS OF WM PETS

Background-Cumulative Impacts. and Existing Cultural Deficit and Inequities

It must be recognized that the Hanford-affected tribes are already suffering a serious cultural deficit from past DOE decisions that contribute to total cultural impacts resulting from the 2006 Plan and WM PEIS. This issue is related to the problem of how to handle the presence of background contaminants, and pre-existing co-fisk factors and stressors. From a community perspective, what matters is the total impact, not what fraction of the impacts comes from DOE or non-DOE sources. This is a policy issue that must be addressed through direct consultation with affected tribes and communities, but which has so far not been open for discussion.

Methods that *Should Have* Been Used in the WM PEIS

The following partial outline is our preferred outline because it contains the information needed to perform a technically defensible and credible FIS (See Table I for more detail).

A. Affected Environment: Summary of Existing Conditions and Quality of the Affected Eco-Human Environment.

1 Physical environment (geomorphology, hydrology, etc.)
2. Terrestrial and aquatic structures, distributions, and processes
3. Domestic and native biotic systems and interfaces
4. Nature's patterns, functions, and services
5. Description of ethno-habitats and ethno-ecologies

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6. Landscapes, and landscape ecology

7. Integrated summary of terrestrial, aquatic, and eco-cultural systems

B. Affected Environment: Human Uses and Values

I. Values, treaties, agreements, obligations, statutes, laws, etc.
2. Historical and current populations/tribes/communities
3. Historic and cultural resources, traditional use and heritage areas
4. Human co-risk factors, environmental stressors, existing cultural deficits

C Impacts: Biologic and Ecologic Resource (Operational, Post-Closure, and Cumulative) (detail omitted for brevity)

D. Impacts: Human Uses and Human Health

1. Impacts on treaty-reserved rights and Federal Trust obligations
2. Human health - individuals, communities, multiple generations across demographic and ethnic groups
3. Socio-cultural impacts (religion, cultural well-being, social impacts, lost or restricted access or use)
4. Socio-economic impacts (including non-market impacts, contingency valuations, impacts to non-market-based communities)
5. Impacts on natural resource trusteeship
6. Impacts on cultural resource trusteeship
7. Impacts on stewardship, sustainability, and other principles

Analytical Methods that Were Used in the WM PEIS

Some of the major deficiencies in the VIM PEIS and 2006 Plan are presented here. The overall effect of the EIS suggests that the analyses may have been generated to support pre-determined decisions.

The affected environment (at least at Hanford) was not adequately described in the WM PEIS. The discussion of land use is internally inconsistent with the assumptions made for human health evaluation, namely that no one would ever be allowed back on site, even for thousands and thousands of years (so only offsite doses were estimated). This violates the EPA requirement to use "reasonably foreseeable land uses' (EPA, OSWER Land Use Directive).

The existence of federal Trust obligations was never mentioned, and treaties with Indian Nations were mentioned only in passing. Indian Tribes were not directly consulted nor included in the preparation of the WM PEIS, nor were they consulted in the preparation of the first WM PBS Record of Decision (TRU Waste), so Trust responsibilities and Treaty law were not reflected in the methodology.

Human health was not adequately evaluated. The health risk section understates risk and overstates supposed "conservatism." Overall, the risks are underestimated by several orders of magnitude. A sample of the deficiencies areas follows. (I) Interacting source terms were only partially considered, and cumulative health effects were not evaluated. In addition, the analyses used to support claims of minimal health effects used a variety of different and contradictory assumptions, time frames, and

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dose limits. (2) The relation between land use and selection of exposure scenarios was misunderstood (and explained in internally contradictory ways in different places) and could have resulted in significant underestimation of doses, (3) The statement that a Native American Subsistence Scenario 'has not received a complete review by the scientific community" (VIM PEIS, p. C-182) is false - it has been extensively peer-reviewed and published in the open peer-reviewed literature, which DOE could have ascertained by talking to the tribes that developed it. (4) The statements that imply that cancer caused by chemicals is different from cancer caused by radionuclides is toxiologically incorrect. (5) The WM FF15 used toxicologic assumptions that admittedly change the absolute risk estimates but supposedly not the relative rankings among Sites. This needs to be revised because the conclusions for individual Sites presents absolute numerical risk results, not relative risk results, yet recommendations about Alternatives are based on numerical results which the text indicates are only screening level and highly inaccurate estimates. The high degree of uncertainty means that conclusions cannot be supported by the numerical results. (6) Because a comprehensive health effects analysis has never been done at Hanford, and because the Hanford "baseline" has never been described in terms of long-term cumulative risk profiles, it is not possible to compare individual alternatives at Hanford, nor to compare Hanford to other Sites.

The Environmental Justice sections should be completely rewritten with input from the affected tribes and communities. Demographics is not the appropriate basis for environmental justice. Tribal lands at Hanford (and apparently at all other Sites, as well) were grossly misrepresented (for instance, there was no indication of ceded areas). Repeated suggestions made by local Tribes about how to evaluate impacts for Hanford and other Sites with tribal or minority populations have been ignored both at Richland and at DOE-HQ. The National Equity Dialogue was ineffectual at capturing these issues. Referring these discussions to the individual field offices serves to divide and conquer disadvantaged populations and prevent them from having an effective voice in the Complex-wide decisions, and will inevitably result in Site EISs that conflict with Complex-wide waste stream FISs.

Cultural resources at Hanford were not adequately described, and local Tribes were never consulted about the wording of this section. Artifacts are NOT the sole measure of cultural resources. Cultural use of natural resources is clearly recognized under federal law and used by various federal agencies as part of cultural resource evaluation.

Conclusions that the WM PEIS Makes about Hanford

Waste stream disposition maps indicate that Hanford would be the largest recipient of LLW by volume (on top of an extremely large and undefined amount of waste already at Hanford) and the second largest recipient by total curies (and the largest recipient of long-lived curies). This effectively creates a Pacific Northwest sacrifice region that fails to meet disposal and repository standards. There is no supporting documentation that indicates that inventory was adequately characterized, that its containment performance is known, that transport of contamination is understood, or that the types of impacts that should be evaluated have been included. The regional effects of Hanford overtime, both with and without additional wastes coming from offsite, have never been evaluated, but our simple analyses indicate that serious impacts can be expected.

The health effects results at Hanford ("less than one cancer fatality in the offsite population") can easily be demonstrated to be grossly underestimated and do not consider cumulative effects from the sources at Hanford. The basic assumptions (for instance, that institutional controls will be maintained for thousands of years) are unacceptable to the affected communities and inconsistent with the methods used on site to negotiate enforceable cleanup actions.

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The statement that "no major impacts to ecological resources, land use, or environmental justice are expected' (WM PEIS Summary, p. 94) at Hanford is completely false. In fact, there are serious present impacts and there will be even higher future adverse effects to natural resources and cultural resources. Many land uses will be permanently precluded. Again, tribes were not consulted about the impacts to their natural and cultural resources, so the information that communities need is not being gathered.

'Although waste management activities may add to cumulative impacts, these additions are not expected to cause standards or guidelines to be exceeded.' This is false. Waste management activities will *significantly* add to cumulative impacts, although the degree of this cumulative effect is completely undefined because no analysis has ever been done to answer that question. The second part of the sentence (that standards will not be exceeded) can easily be shown to be false. Many individual sources at Hanford will each exceed various standards, as shown by the Tank Waste Remediation System ELS (DOE, 1996) and numerous performance assessments prepared in support of operations and disposal activities.

OUR CONCLUSIONS ABOUT HANFORD COMMUNITY EQUITY AND INTER-SITE EQUITY

Although we applaud the goal of integrating ER and WM activities, DOE is not gathering the proper information to do this. NEPA is supposed to "thoroughly analyze' the health and environmental impacts of the various alternatives (DOE 1997b: Fact Sheet), yet the analysis in the VIM PEIS falls so short of this requirement that the preferred alternatives are clearly insupportable. From our perspective, DOE has steadfastly refused to consider the full range of impacts that communities typically experience, the full spatial area that is affected, and the full temporal duration of those impacts. Putting risks into a regional context and into an ethical context remains a critical deficiency in DOE decision making. This has resulted and continues to result in decisions that ignore some of the most important consequences and that treat cost and schedule with more respect than values and principles. Specifically,

1. DOE is not meeting its Federal Trust obligations. DOE has placed itself at considerable regulatory risk by refusing to consider Trust obligations. Prospectively, identifying Trust responsibility must be a constant decision-making principle, not just a post-remediation factor.
2. DOE is not honoring treaty-reserved rights. Treaty rights were completely ignored. Most particularly, Treaties guarantee on-site subsistence uses, while the PETS considered only off site uses non-subsistence use.
3. DOE-HO is not meeting its consultation requirements. DOE has not consulted with Tribes on the WM PEIS or any supporting documents. The 'disposition of comments' received by DOE at various stages of the NEPA process is an effective way to exclude tribes and communities from the real decision making process. DOE is violating both it's Indian Policy and its Environmental Justice Policy, and is violating the intent of NEPA with respect to public participation.
4. DOE is not adequately protecting human health or the environment. As we have shown, risks are underestimated by several orders of magnitude at Hanford, yet DOE refuses to discuss ways to improve its scientific credibility. Many types of risk were ignored altogether, resulting in a seriously deficient database.
5. DOE is not anticipating the full degree of long-term stewardship needs. The Hanford 2006 Plans says that 'stewardship' begins sometime around 2050-2070, while the WM PEIS implies

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that it begins in 100 years when institutional controls fail. The health results, however, never include onsite (post-institutional controls) analysis. The true long-term risks and the magnitude of long-term stewardship that will be required for residual and disposed waste is not known. The optimistic assumption that stewardship is an organized program that steps in and manages Sites in perpetuity is inadequate.

6. Communities are being misled about relevant decision documents. For instance, DOE's Contractor-Led Integration Report was presented to affected communities by DOE Headquarters and Richland staff strictly as a non-decisional supporting database, yet it is formally cited in the 2006 Plan and in the Fact Sheet as the source of recommendations made for the WM PEIS. Since the Tribes and Site Specific Advisory Boards were told by DOE Headquarters representatives to disregard the Contractor's Integration Report, it should not be used, and the methods and scope should be reopened.
7. DOE is not trying to achieve equity or satisfy environmental justice. DOE's plans will exacerbate the existing impacts to human health and the environment, including socio-cultural aspects of the environment, and will also worsen the inequitable distribution of adverse impacts among the affected communities at Hanford.
8. Regional impacts and inequities have not been evaluated. A 50-mile demographic count is not the correct basis for impact assessments at many Sites, and is particularly inappropriate for Hanford which includes the Columbia River acting as a distribution system for the Pacific Northwest.
9. Decision criteria doe not reflect community values. The decision criteria (Summary Table 1.6-1 of the WM PUS) are not acceptable to tribes and affected communities (nor have tribes been consulted), and in any event the VIM PEIS DOES not evaluate the impacts in a way such that those criteria could actually be used. For instance, the DOE mission may be waste disposal, as another example, but the Hanford mission has repeatedly stated as cleanup, not disposal. As another example, the criteria "favors alternatives ... that are considered equitable," yet there is no discussion of what DOE considers equitable, and no data by which equity can be evaluated.

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Table 1. RISK MEASURES. Measures for Human Health, Environmental/Ecological Health, and Socio-cultural Health.

Type of consequence	**Endpoint Measure**
Human Health effects (depending on community concerns and likely target tissue effects of identified of contaminants). These measures include effects of maximum concentrations on individuals and communities as well as prolonged or multi-generational effects of subthreshold exposures for each parameter.	●Cancer ●Hazard Index ●Reproductive, teratogenic, and developmental effects ●Immunological effects ●Neurological and neurobehavioral effects ●Mutagenicity (including small gene pools) ●Metabolic effects ●Endocrine effects ●Derinal effects ●Other effects (according to toxicity profile of the contaminant ●Population effects in the present generation (total community exposure, community health, and community well-being) ●Population effects in future generations ●Proportion of the community or group affected ●Other health indices and indicators, using public health methods relating to indirect effects, functionality, psychosocial health, etc.

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Identification of population segment(s) and lifestyles to be evaluated (which person or people, and which activities), which is used to select exposure scenarios and exposure pathways.	● Age (children, elders, women of child-bearing age, breastfeeding infants) ● Gender ● Selected percentile (mean, 75^{th}, 95^{th}, other) for the maximally exposed individual ● Selected community activity or lifestyle (subsistence resident hunters, basketweavers, others as indicated by affected habitat types). ● Other groups with more distant exposures (such as consumers, members of extended families and trade networks), but with many members; populations over time. ● Unique cultural activities such as use of the sweat lodge ● Other standard community or social activities such as recreation, suburban, agricultural resident, industrial, and other CERCLA, or site-specific scenarios
Co-risk factors affecting degree of exposure and degree of response	● Multiple exposures (additional contaminants from same or other sources, including occupation) ● Biochemical genetics and ethnopharinacology ● Underlying health effects (individual or population, using health statistics where available) ● Nutritional status and dietary quality, including affects of substitute diet if the traditional diet is unavailable ● Socioeconomic status ● Access to health care, insurance, and education

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Environmental quality measures (with attributes for each measure of magnitude or severity, area or extent or fraction affected, and time to complete recovery). These measure includes effects of maximum concentrations as well as prolonged or multigenerational exposures to subthreshold concentrations	●Contamination or degradation of environmental media (concentration and area or volume affected, and duration of effect) ●Ecotoxicity to individual organisms of selected species both at the location and whose homerange or migratory range touch the affected area (keystone ecological species, T&E species, culturally important species, indicator and sentinel species). ●Sub-lethal effects such as endocrine disruption ● Mutagenicity in animals, fish, birds ● Ecotoxicity to communities, populations, including indirect effects such as whether the location provides nesting cover, nutrients for other species, other things) ●Biodiversity and ecosystem integrity ●Habitat functions and services (soil stability, biofiltering ●Landscape ecology, landscape functions and services ●Aesthetics and visual integrity
Selection of Biotic Receptors	●Individual species or simple foodchains ●Foodwebs and communities ●Ecosystem ●Ethno-habitats
Environmental co-risk factors affecting ecological sensitivity (other stressors and species specific sensitivity)	●Other chemical, radiological contaminants; total ecological contaminant burden ●Physical, thermal, and biological stressors ●Political, legal, institutional threats (e.g. zoning leading to fragmentation) ●Current quality relative to original or ideal conditions (measures of habitat value)

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Socio-cultural and socio-economic factors (based on what uses the local resources are put to, what activities occur at the location, what "user groups" are affected by lost access or use of the place or one of its resources)	●Lost access or use of place or resource (duration of loss, of loss relative to original conditions, residual quality if partially lost or not fully restored) ●Community well-being and social and family cohesiveness maintained through use of the place or resource ●Everyday life and material implements derived from the place or resource, and living and social activities and practices associated with the place or resource ●Religious, ceremonial well-being gained through use of the place or resource ●Other uses of the site or resource such as education, art, or trade ●Intergenerational continuity in knowledge, language, traditions, values, and education related to the place or resource ●Physical integrity of historical or cultural resources located in the place or associated with use of the resource ●Economic impacts of losing the place or resource (direct impacts of commercial, trade, jobs, services, avoidance costs) ●Replacement costs (duration of loss x annual cost x quality and convenience of replacement, x proportion of community affected by the loss) ●Other costs of avoiding exposure ●Other costs of "intangibles" and "externalities" using contingency valuation methods without discounting ●Costs to future generations, such as monitoring and surveillance costs, or increased remediation and restoration costs if contamination spreads or the resource is impaired. Permanent loss may mean infinite costs or requirements for permanent mitigation.
Selection of socio-cultural receptor groups, activities, locales	●General suburban surrounding area ●Native American Tribes and Bands ●Ethnic groups such as migrant workers, ethnic communities ●Socio-economic groups ●Particular regional activities such as agriculture or recreation

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Co-risk factors affecting socio-cultural sensitivity	●Current adequacy of social services that might increase costs of the impacts proportionally more than in affluent communities ●Past history of impacts to specific cultures and peoples and cumulative impacts up to the present ●Current cultural "resiliency." and current quality of treaty rights ●Institutional factors (trust, credibility, openness, probable stability of current agreements)
Additional **values** that may be impacted by the stressor or planned action	●Sustainability ●Precautionary decision making and protection ●Active trusteeship and responsible stewardship of land and treaties ●Preservation of future land use options

Note that not all of these measures are required for every analysis; different decisions will tolerate different amounts of uncertainty and be sensitive to different paramaters.

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